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ABSTRACT

A U-spin relation among four ratios of amplitudes for $D^0 \rightarrow \pi^+ K^-, K^+ \pi^-, K^+ K^-, \pi^+ \pi^-$, including first, second and third order U-spin breaking, has been derived recently with a precision of 10^{-3} . We study effects of new $|\Delta C| = 1$ operators on this relation. We find that it is not affected by U-spin scalar operators, including QCD penguin and chromomagnetic dipole operators occurring in supersymmetric and extra-dimensional models. The relation is modified by new $U = 1$ operators with a sensitivity of a few percent characteristic of second order U-spin breaking. Combining this relation with CP asymmetries in $D^0 \rightarrow K^+ K^-, \pi^+ \pi^-$ leads to a more solid constraint on $U = 1$ operators than from asymmetries alone.

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1. Introduction

Indirect evidence for new physics in processes involving charmed mesons may be obtained in two ways:

- Very rare processes could be measured with rates that exceed unambiguously predictions within the Standard Model.
- Very precise amplitude relations predicted within the Standard Model could be violated experimentally.

Two properties of charmed mesons, D^0 – \bar{D}^0 mixing and CP violation in singly Cabibbo-suppressed (SCS) D meson decays, have been suggested as potential cases for the first scenario [1–3]. Recently we derived a very precise nonlinear relation among four ratios of amplitudes for $D^0 \rightarrow \pi^+ K^-, K^+ \pi^-, K^+ K^-, \pi^+ \pi^-$ [4], valid up to fourth order U-spin breaking. While precise amplitude relations have already been proposed for hadronic B meson decays (see for instance Ref. [5]), this particular relation provides a first case for the second scenario in hadronic D decays.

Measurements of the difference between CP asymmetries in $D^0 \rightarrow K^+ K^-$ and $D^0 \rightarrow \pi^+ \pi^-$ of order 10^{-3} [6–8] have been shown to be consistent with Standard Model estimates [9]. This has been used to obtain model-dependent constraints on new $|\Delta C| = 1$ operators occurring in a number of models [10]. The amplitude relation derived in Ref. [4], involving a precision of 10^{-3} , has been shown to agree with experiment at this same high accuracy. The purpose of this letter is to study the possibility of using this excellent agreement for obtaining model-independent constraints on new $|\Delta C| = 1$ operators.

The proof in [4] of the nonlinear amplitude relation is based largely on the fact that the charm-changing weak hamiltonian

transforms as a U-spin triplet [11,12]. Thus we will distinguish between two classes of models involving new $|\Delta C| = 1$ operators behaving distinctly under U-spin. In the first case we will assume these operators to transform like U-spin scalars. This rather broad class of models includes supersymmetric and extra-dimensional models involving new QCD penguin and chromomagnetic dipole operators. Constraints on such models from CP asymmetries in SCS D decays and from D^0 – \bar{D}^0 mixing have been studied in Refs. [3] and [13]. A second class of models includes new $|\Delta C| = 1$ operators transforming like $U = 1$, $U_3 = 0$. Constraints on such operators from CP asymmetries in SCS decays have been discussed in Ref. [14]. Other probes for new physics have been suggested in Ref. [15] in terms of isospin sum rules for CP asymmetries in SCS D decays.

Section 2 summarizes briefly arguments used in Ref. [4] leading to a precise nonlinear relation among four ratios of amplitudes for $D^0 \rightarrow \pi^+ K^-, K^+ \pi^-, K^+ K^-, \pi^+ \pi^-$. In Sections 3 and 4 we study separately contributions of new $U = 0$ and $U = 1$, $U_3 = 0$ operators potentially modifying this relation. Section 5 contains a discussion of CP asymmetries in $D^0 \rightarrow K^+ K^-$ and $D^0 \rightarrow \pi^+ \pi^-$ in these two classes of models. Conclusions are given in Section 6.

2. Precise amplitude relation in the Standard Model

Hadronic weak decays of charmed mesons are conveniently studied using U-spin symmetry under which the quark pair (d, s) transforms like a doublet. The effective Hamiltonian operators for Cabibbo-favored (CF), singly Cabibbo-suppressed (SCS) and doubly Cabibbo-suppressed charm decays transform like three components $U_3 = -1, 0, +1$ of $U = 1$, excluding corresponding CKM factors, $\cos^2 \theta_C$, $-\cos \theta_C \sin \theta_C$, $\sin^2 \theta_C$.

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We neglect a term in the SCS Hamiltonian proportional to a tiny CKM factor $V_{cb}^* V_{ub}$, where $|V_{cb}^* V_{ub}|/\cos\theta_C \sin\theta_C \simeq 0.7 \times 10^{-3}$ [16]. This term would be responsible for CP asymmetries of this order in $D^0 \rightarrow K^+ K^-$ and $D^0 \rightarrow \pi^+ \pi^-$. Since the measured CP asymmetries are at most of this order [8], while our approximation for amplitudes involves uncertainties of this same order, we will neglect CP asymmetries also in the next two sections discussing new physics, returning to discuss them in Section 5.

The D^0 is a U-spin singlet, the states $|\pi^+ K^- \rangle$, $\frac{1}{\sqrt{2}}|K^+ K^- - \pi^+ \pi^- \rangle$, $|K^+ \pi^- \rangle$ are three components $|U_3 = -1, 0, +1\rangle$ of $|U = 1\rangle$ while $\frac{1}{\sqrt{2}}|K^+ K^- + \pi^+ \pi^- \rangle$ is a singlet. The matrix element of the $U = 1$ Hamiltonian vanishes for the latter state, $\langle K^+ K^- | \mathcal{H}_{\text{eff}} | D^0 \rangle = -\langle \pi^+ \pi^- | \mathcal{H}_{\text{eff}} | D^0 \rangle$. Thus in the U-spin symmetry limit the four amplitudes for $D^0 \rightarrow \pi^+ K^-$, $K^+ K^-$, $\pi^+ \pi^-$, $K^+ \pi^-$ are given by a common $U = 1$ amplitude A . Consequently the multiple ratio of the four decay amplitudes is given by ratios of CKM factors [17]:

$$\begin{aligned} A(D^0 \rightarrow \pi^+ K^-) : A(D^0 \rightarrow K^+ K^-) : A(D^0 \rightarrow \pi^+ \pi^-) \\ : A(D^0 \rightarrow K^+ \pi^-) \\ = \cos^2 \theta_C : \cos \theta_C \sin \theta_C : -\cos \theta_C \sin \theta_C : -\sin^2 \theta_C. \end{aligned} \quad (1)$$

U-spin breaking in amplitudes is treated perturbatively in terms of two distinct parameters proportional to $(m_s - m_d)/\Lambda_{\text{QCD}}$, taken separately for $D^0 \rightarrow \pi^+ K^-$, $K^+ \pi^-$ and $D^0 \rightarrow K^+ K^-$, $\pi^+ \pi^-$. Symmetry breaking of order k in an amplitude $\langle f | \mathcal{H}_W | D^0 \rangle$ is obtained by introducing in \mathcal{H}_W or in $|f\rangle$ k powers of a quark mass-difference operator $\bar{s}s - \bar{d}d$ behaving like $U = 1$, $U_3 = 0$. The decays $D^0 \rightarrow K^+ K^-$, $\pi^+ \pi^-$ obtain also a first order U-spin breaking correction from a $U = 0$ penguin operator. This and a simple sign property for U-spin addition, $(1, -1; n, 0 | 1, -1) = (-1)^n (1, 1; n, 0 | 1, 1)$, lead to the following two properties of U-spin breaking [4]:

- Symmetry breaking effects in $D^0 \rightarrow \pi^+ K^-$, $K^+ \pi^-$ and $D^0 \rightarrow K^+ K^-$, $\pi^+ \pi^-$ are described by two different parameters, to be denoted ϵ_1 and ϵ_2 , respectively.
- In each one of these two pairs of processes U-spin breaking corrections of even (odd) order have equal magnitudes and same (opposite) signs.

Expanding up to third order U-spin breaking one has

$$\begin{aligned} A(D^0 \rightarrow \pi^+ K^-) &= \cos^2 \theta_C A [1 - \epsilon_1 + a_1(\epsilon_1)^2 - a'_1(\epsilon_1)^3], \\ A(D^0 \rightarrow K^+ \pi^-) &= -\sin^2 \theta_C A [1 + \epsilon_1 + a_1(\epsilon_1)^2 + a'_1(\epsilon_1)^3], \\ A(D^0 \rightarrow K^+ K^-) &= \cos \theta_C \sin \theta_C A [1 + \epsilon_2 + a_2(\epsilon_2)^2 + a'_2(\epsilon_2)^3], \\ A(D^0 \rightarrow \pi^+ \pi^-) &= -\cos \theta_C \sin \theta_C A [1 - \epsilon_2 + a_2(\epsilon_2)^2 - a'_2(\epsilon_2)^3], \end{aligned} \quad (2)$$

where $a_{1,2} \sim a'_{1,2} \sim 1$.

Defining four independent ratios of amplitudes R_i ($i = 1, 2, 3, 4$) one finds:

$$\begin{aligned} R_1 &\equiv \frac{|A(D^0 \rightarrow K^+ \pi^-)|}{|A(D^0 \rightarrow \pi^+ K^-)| \tan^2 \theta_C} = 1 + 2[\text{Re} \epsilon_1 + (\text{Re} \epsilon_1)^2] \\ &= 1.118 \pm 0.014, \\ R_2 &\equiv \frac{|A(D^0 \rightarrow K^+ K^-)|}{|A(D^0 \rightarrow \pi^+ \pi^-)|} = 1 + 2[\text{Re} \epsilon_2 + (\text{Re} \epsilon_2)^2] \\ &= 1.814 \pm 0.018, \end{aligned}$$

Table 1

Amplitudes in units of $10^{-1}(\text{GeV}/c)^{-1/2}$ for D^0 decays to pairs involving a charged pion and kaon.

| Decay mode | $ A = \sqrt{\mathcal{B}/p^*}$ |
|-------------------------------|--------------------------------|
| $D^0 \rightarrow \pi^+ K^-$ | 2.1228 |
| $D^0 \rightarrow K^+ \pi^-$ | 0.1268 \pm 0.0012 |
| $D^0 \rightarrow K^+ K^-$ | 0.7076 \pm 0.0052 |
| $D^0 \rightarrow \pi^+ \pi^-$ | 0.3900 \pm 0.0027 |

$$\begin{aligned} R_3 &\equiv \frac{|A(D^0 \rightarrow K^+ K^-)| + |A(D^0 \rightarrow \pi^+ \pi^-)|}{|A(D^0 \rightarrow \pi^+ K^-)| \tan \theta_C + |A(D^0 \rightarrow K^+ \pi^-)| \tan^{-1} \theta_C} \\ &= 1 + \frac{1}{2}[(\text{Im} \epsilon_2)^2 - (\text{Im} \epsilon_1)^2] + \text{Re}[a_2(\epsilon_2)^2 - a_1(\epsilon_1)^2] \\ &= 1.056 \pm 0.008, \\ R_4 &\equiv \sqrt{\frac{|A(D^0 \rightarrow K^+ K^-)| |A(D^0 \rightarrow \pi^+ \pi^-)|}{|A(D^0 \rightarrow \pi^+ K^-)| |A(D^0 \rightarrow K^+ \pi^-)|}} \\ &= 1 + \frac{1}{2}[(\text{Im} \epsilon_2)^2 - (\text{Im} \epsilon_1)^2] + \text{Re}[a_2(\epsilon_2)^2 - a_1(\epsilon_1)^2] \\ &\quad - \frac{1}{2}[(\text{Re} \epsilon_2)^2 - (\text{Re} \epsilon_1)^2] \\ &= 1.012 \pm 0.007. \end{aligned} \quad (3)$$

R_1 and R_2 involve additional third order terms while corrections to R_3 and R_4 start at fourth order. [The last term of Eq. (21) in [4] should be of fourth order.] In the above we used the following third order expansion:

$$\begin{aligned} |1 \pm \epsilon + a\epsilon^2 \pm a'\epsilon^3| \\ = 1 \pm \text{Re} \epsilon + \frac{1}{2}(\text{Im} \epsilon)^2 + \text{Re}(a\epsilon^2) \pm \text{Re}(a'\epsilon^3) \mp \frac{1}{2} \text{Re} \epsilon (\text{Im} \epsilon)^2 \\ \mp \text{Im} \epsilon \text{Im}(a\epsilon^2). \end{aligned} \quad (4)$$

Numerical values on the right hand sides of (3) have been obtained using $\tan \theta_C = 0.2312 \pm 0.0009$ and branching fractions for $D^0 \rightarrow K^+ \pi^-$, $K^+ K^-$, $\pi^+ \pi^-$ measured relative to $D^0 \rightarrow \pi^+ K^-$ [16]. Table 1 quotes magnitudes of the four amplitudes defined by $|A| \equiv \sqrt{\mathcal{B}/p^*}$. Note that the first amplitude involves no error as the three others are measured relative to its magnitude.

The second order expressions in (3) imply $\text{Re} \epsilon_1 = 0.056 \pm 0.006$, $\text{Re} \epsilon_2 = 0.311 \pm 0.006$, and a nonlinear relation among these four ratios which holds up to fourth order U-spin breaking:

$$\Delta R \equiv R_3 - R_4 + \frac{1}{8}[(\sqrt{2R_1 - 1} - 1)^2 - (\sqrt{2R_2 - 1} - 1)^2] = 0. \quad (5)$$

This relation is satisfied extremely well by current experiments for which one finds

$$\Delta R_{\text{exp}} = -0.003 \pm 0.002. \quad (6)$$

We have neglected in Eq. (5) a fourth order U-spin breaking correction and an isospin breaking term suppressed also by U-spin breaking. This leads to an uncertainty of order 10^{-3} [4].

3. Contributions of a new $U = 0$ operator

A new $U = 0$ operator does not contribute to $D^0 \rightarrow \pi^\pm K^\mp$ where final states have $U_3 = \mp 1$. This is true in the U-spin symmetry limit and also when including U-spin breaking of arbitrary order. We will assume that contributions of this operator in $D^0 \rightarrow K^+ K^-$ and $D^0 \rightarrow \pi^+ \pi^-$ are subleading, namely of order ϵ_2 or smaller, as are the U-spin breaking contributions of a

$U = 0$ penguin operator occurring in the CKM framework [4]. In these two processes the new $U = 0$ operator has equal contributions in the U-spin symmetry limit and first order U-spin breaking terms of equal magnitudes and opposite signs. Normalizing these two contributions by the $U = 1$ amplitude we denote them by $\cos\theta_C \sin\theta_C A n$ and $\cos\theta_C \sin\theta_C A n\epsilon$, respectively:

$$\begin{aligned} A(D^0 \rightarrow K^+ K^-) &= \cos\theta_C \sin\theta_C A [1 + \epsilon_2 + a_2(\epsilon_2)^2 + a'_2(\epsilon_2)^3 + n + n\epsilon], \\ A(D^0 \rightarrow \pi^+ \pi^-) &= -\cos\theta_C \sin\theta_C A [1 - \epsilon_2 + a_2(\epsilon_2)^2 - a'_2(\epsilon_2)^3 - n + n\epsilon]. \end{aligned} \quad (7)$$

Here we wish to study the effects of these new terms on (3) and (5).

Expanding ratios of amplitudes up to and including terms of second order in n and in the U-spin breaking parameters $\epsilon_1, \epsilon_2, \epsilon$, one obtains

$$\begin{aligned} R_1 &= 1 + 2[\text{Re}\epsilon_1 + (\text{Re}\epsilon_1)^2], \\ R_2 &= 1 + 2[\text{Re}(\epsilon_2 + n) + (\text{Re}(\epsilon_2 + n))^2], \\ R_3 &= 1 + \frac{1}{2}[(\text{Im}(\epsilon_2 + n))^2 - (\text{Im}\epsilon_1)^2] \\ &\quad + \text{Re}[a_2(\epsilon_2)^2 - a_1(\epsilon_1)^2 + n\epsilon] \\ R_4 &= 1 + \frac{1}{2}[(\text{Im}(\epsilon_2 + n))^2 - (\text{Im}\epsilon_1)^2] \\ &\quad + \text{Re}[a_2(\epsilon_2)^2 - a_1(\epsilon_1)^2 + n\epsilon] \\ &\quad - \frac{1}{2}[(\text{Re}(\epsilon_2 + n))^2 - (\text{Re}\epsilon_1)^2]. \end{aligned} \quad (8)$$

These results correspond to a substituting $\epsilon_2 \rightarrow \epsilon_2 + n$ and $a_2(\epsilon_2)^2 \rightarrow a_2(\epsilon_2)^2 + n\epsilon$ in (3).

Thus the ratio R_2 involves a term which is first order in the $U = 0$ amplitude. It implies $\text{Re}(\epsilon_2 + n) = 0.311 \pm 0.006$. The ratios R_3 and R_4 include identical second order terms depending on the $U = 0$ amplitude that cancel in their difference occurring in ΔR . Since Eqs. (8) have the same structure as Eqs. (3), with a mere substitution, $\epsilon_2 \rightarrow \epsilon_2 + n$, $a_2(\epsilon_2)^2 \rightarrow a_2(\epsilon_2)^2 + n\epsilon$, the nonlinear relation (5) still holds. That is, Eq. (5) is unaffected by arbitrary new $U = 0$ operators and cannot be used to constrain such operators.

4. Contributions of a new $U = 1, U_3 = 0$ operator

Consider now models with new $U = 1, U_3 = 0$ operators. The effect of such operators on (2) is to modify the overall factor in the amplitudes for $D^0 \rightarrow K^+ K^-, \pi^+ \pi^-$, and to replace the U-spin breaking parameter ϵ_2 by a new parameter ϵ'_2 , corresponding to U-spin breaking in the total $U = 1, U_3 = 0$ amplitude. Using a parameter n to normalize the new amplitude by the U-spin invariant amplitude A , one has

$$\begin{aligned} A(D^0 \rightarrow K^+ K^-) &= \cos\theta_C \sin\theta_C A(1+n)[1 + \epsilon'_2 + a_2(\epsilon'_2)^2 + a'_2(\epsilon'_2)^3], \\ A(D^0 \rightarrow \pi^+ \pi^-) &= -\cos\theta_C \sin\theta_C A(1+n)[1 - \epsilon'_2 + a_2(\epsilon'_2)^2 - a'_2(\epsilon'_2)^3]. \end{aligned} \quad (9)$$

Expanding the four ratios of amplitudes up to second order, we note that R_1 and R_2 are essentially unaffected relative to (3) while R_3 and R_4 obtain an overall factor $|1+n|$:

$$\begin{aligned} R_1 &= 1 + 2[\text{Re}\epsilon_1 + (\text{Re}\epsilon_1)^2], \\ R_2 &= 1 + 2[\text{Re}\epsilon'_2 + (\text{Re}\epsilon'_2)^2] \quad \text{implying } \text{Re}\epsilon'_2 = 0.311 \pm 0.006, \\ R_3 &= |1+n| \left[1 + \frac{1}{2}[(\text{Im}\epsilon'_2)^2 - (\text{Im}\epsilon_1)^2] \right. \\ &\quad \left. + \text{Re}[a'_2(\epsilon'_2)^2 - a_1(\epsilon_1)^2] \right], \\ R_4 &= |1+n| \left[1 + \frac{1}{2}[(\text{Im}\epsilon'_2)^2 - (\text{Im}\epsilon_1)^2] \right. \\ &\quad \left. + \text{Re}[a'_2(\epsilon'_2)^2 - a_1(\epsilon_1)^2] - \frac{1}{2}[(\text{Re}\epsilon'_2)^2 - (\text{Re}\epsilon_1)^2] \right]. \end{aligned} \quad (10)$$

Thus the relation (5) is now modified to

$$R_3 - R_4 + \frac{1}{8}|1+n|[(\sqrt{2R_1-1}-1)^2 - (\sqrt{2R_2-1}-1)^2] = 0, \quad (11)$$

leading to the following constraint on the complex parameter n representing a new $U = 1, U_3 = 0$ amplitude:

$$|1+n| = \frac{R_3 - R_4}{\frac{1}{8}[(\sqrt{2R_2-1}-1)^2 - (\sqrt{2R_1-1}-1)^2]}. \quad (12)$$

Using values of amplitudes given in Table 1 we calculate

$$|1+n| \simeq 1 + \text{Re}n = (0.95 \pm 0.02)[1 + \mathcal{O}((\epsilon_1)^2, (\epsilon'_2)^2)]. \quad (13)$$

Fourth order U-spin breaking corrections have been neglected in the numerator and denominator of (12), which by themselves are both of second order. Therefore Eq. (13) is valid up to second order U-spin breaking. Second order terms in R_3 and R_4 in (3) have been shown to be between one and five percent. Adding in quadrature this uncertainty and the experimental error in (13) we obtain

$$\text{Re}n = -0.05 \pm 0.05. \quad (14)$$

5. CP asymmetries in $D^0 \rightarrow K^+ K^-, \pi^+ \pi^-$

In the preceding sections we have neglected CP asymmetries in $D^0 \rightarrow K^+ K^-, \pi^+ \pi^-$, which are expected to be at most of order 10^{-3} in the CKM framework in agreement with experiments [8]. We have also neglected these asymmetries in the presence of new operators, consistent with neglecting fourth order U-spin breaking which introduces uncertainties of this order. In general, hadronic matrix elements of these new operators may involve a CP-violating phase ϕ and a strong phase δ , $n = |n|e^{i\delta}e^{i\phi}$. Consequently the two processes, $D^0 \rightarrow K^+ K^-, \pi^+ \pi^-$ acquire nonzero CP asymmetries,

$$A_{\text{CP}}(D^0 \rightarrow f) \equiv \frac{|A(D^0 \rightarrow f)|^2 - |\bar{A}(\bar{D}^0 \rightarrow \bar{f})|^2}{|A(D^0 \rightarrow f)|^2 + |\bar{A}(\bar{D}^0 \rightarrow \bar{f})|^2}, \quad (15)$$

which are proportional to $|n| \sin\delta \sin\phi$. The ratios of amplitudes R_i in Eqs. (3) are now defined in terms of CP-averaged amplitudes

$$|A(D^0 \rightarrow f)|_{\text{CPav}} \equiv \sqrt{\frac{1}{2}[|A(D^0 \rightarrow f)|^2 + |\bar{A}(\bar{D}^0 \rightarrow \bar{f})|^2]}. \quad (16)$$

These amplitudes involve a term $|n| \cos\delta \cos\phi$ instead of $\text{Re}n$ occurring in the above discussion neglecting CP asymmetries. We now summarize the situation of ΔR and A_{CP} defined in (5) and (15) in the presence of a new CP violating phase ϕ .

- For new $U = 0$ operators the ratio R_2 and the difference $R_3 - R_4$ obtain expressions as in (3) where one substitutes $\text{Re}\epsilon_2 \rightarrow \text{Re}\epsilon_2 + |n| \cos\delta \cos\phi$. Thus Eq. (5) holds also for $\phi \neq 0$.

The two CP asymmetries are equal in the U-spin symmetry approximation and have opposite signs (as are small CKM asymmetries [11]),

$$A_{\text{CP}}(D^0 \rightarrow \pi^+ \pi^-) \simeq -A_{\text{CP}}(D^0 \rightarrow K^+ K^-) \simeq 2|n| \sin \delta \sin \phi. \quad (17)$$

- For new $U = 1$ operators Eq. (14) becomes

$$|n| \cos \delta \cos \phi = -0.05 \pm 0.05. \quad (18)$$

The two asymmetries are exactly equal and have the same sign,

$$A_{\text{CP}}(D^0 \rightarrow \pi^+ \pi^-) = A_{\text{CP}}(D^0 \rightarrow K^+ K^-) \simeq -2|n| \sin \delta \sin \phi. \quad (19)$$

Experimental constraints of CP asymmetries on $|n|$ implied by (17) or (19) depend on unknown values of δ and ϕ . An uncertainty in the factor $\sin \delta \sin \phi$ is intrinsic in all earlier work studying constraints on new physics from CP asymmetries in singly Cabibbo-suppressed D decays [3,10]. One often assumes $\sin \delta \sin \phi \sim 1$, thereby obtaining the strongest possible constraint on $|n|$ of order 10^{-3} . However, the constraint becomes much weaker for small values of ϕ or δ and no constraint is obtained for $\phi = 0$ or $\delta = 0$.

Our other restriction (18) involves the factor $\cos \delta \cos \phi$ which is complementary to $\sin \delta \sin \phi$, becoming maximal for $\phi = 0, \delta = 0$. Thus combining (18) and (19) leads to a more robust constraint on $|n|$ than obtained by using merely the two CP asymmetries.

We note in passing that the new amplitude n is absorbed into the definitions of $A(D^0 \rightarrow K^+ K^-)$ and $A(D^0 \rightarrow \pi^+ \pi^-)$ in (9). Therefore it does not affect the contributions of these amplitudes to the $D^0 - \bar{D}^0$ mixing parameter $y \equiv \Delta\Gamma/2\Gamma$. These contributions are only a small fraction of the measured mixing parameter [12].

6. Conclusion

We have studied the effects of new physics operators on a precise U-spin relation for D^0 decays to pairs involving a charged pion or kaon. We have shown that this relation is unaffected by new $U = 0$ operators, while its sensitivity to new $U = 1$ operators is at a level of a few percent characteristic of second order U-spin breaking. The two classes of models involving $U = 0$ and $U = 1$ operators may be distinguished by the relative sign of CP asymmetries in $D^0 \rightarrow K^+ K^-$ and $D^0 \rightarrow \pi^+ \pi^-$.

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